

Implementation of E- Learning Using Digital Video Broadcasting-Return Channel Via Satellite (DVB-RCS) in Ghana

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Abstract: *This paper presents solution to satellite communication technologies to improve quality of education and the benefit of digital technology to where previously Information and communication Technology (ICT) infrastructure could not reach in Ghana. The target is to establish the best connectivity, infrastructure and services for E-learning and cooperate organizations in urban educational institutions and large rural and remote locations that lack infrastructure. The huge cost for wideband and significant broadband connectivity requirements, quality delivery of content, applications interactivity is the bases for exploiting DVB-RCS technology. The Architecture of DVB-RCS based satellite network supports interactive and multimedia applications. This network will deliver live streaming contents to numerous users simultaneously at any time anywhere. The aim is an implementation of high bandwidth multicast satellite technologies for education. The technology address live streaming of voice, data and video over IP contents simultaneously to numerous users in any location. This initiative is part of development of a two way satellite network, to support E-learning environments with emphasis with situations in Ghana, with solutions based on Digital Video Broadcasting-Return Channel via Satellite.*

Keywords: DVB-RCS, E-learning, Satellite, VSAT, Multimedia.

1. Introduction

Application of technology in education has promoted the concept of e-learning which utilizes information and communication technology (ICT) via internet to create, enable, deliver and facilitate lifelong learning. E-learning is based on internet-enabled learning experience. The contents may include delivery in multiple formats, management of the learning experience, and a network community of learners, content developers and experts [7]. The huge potential for using information and communication technology (ICT) to promote E-learning is best the way, to enhance the traditional learning systems by extending education to broader audience who previously have to access and need to improve their literacy, social and economic state [10]. Improving E-learning provide a lot of advantages which includes:

- Expanding access to educational resources for a larger user base.
- Increase availability of information for all users
- Improved lifestyle of the populace regardless of their social or economic status.
- Ability to apply e-resources regardless of the user's background.

There are many locations around the world where social, economic and geographic conditions have limited access to full education. Majority of the world's population live in suburban, rural and remote locations with little or no accesses to internet or communication and academic facilities [9]. This is the case for developing countries like

Ghana majority of the population in the country has no accesses to communication facilities, distancing them from quality education, social and health care facilities. Therefore, satellite network technologies with multimedia and internet capable is the best suitor for provision for e-learning [3]. These satellite network technologies for multimedia can be used to create, deliver and facilitate learning anytime anywhere. It enhances the delivery of comprehensive, individualized, and dynamic learning contents to support the development of communities, linking learners and practitioners with experts on real time bases [2]. These technologies also support high speed and high quality multimedia services with different quality of service (QoS) requirements. These multimedia applications including high-speed Internet, IP multicast, distance education (e-learning) and telemedicine require higher and flexible data rate and two-way communications [7][9]. This forms the reasons for the provision of an interactive channel for with satellite networks with fixed return channel terminals. The satellite link can connect most remote and rural communities to departments, institutions and universities in metropolitan areas anywhere at any time in the country due to lack of terrestrial infrastructure. This satellite network, known as Digital Video Broadcast-Return Channel via Satellite (DVB-RCS) is efficient and supports all internet broadband service. It has emerged as the platform to integrate satellite broadcasting capabilities with the internet infrastructure. The architecture of the system defines the basic set of functionalities required for user's interactivity across the satellite DVB-S distribution system. With global internet becoming a multi-service infrastructure for new opportunities and applications for e-services. DVB-RCS is capable of providing efficient bandwidth which can support

applications in urban, suburban, rural and remote locations and on stationary and mobile platforms. It requires rapid installation and capable of supporting IPTV, high speed internet service, Voice over IP (VoIP), and Voice, Data and Video over IP (VDVoIP) for E-learning and even E-medicine and E-banking[5].

2. E-Learning Related Approach

Generally, e-learning has a wider application than just online, virtual based, distributed, networked or web-based learning. It incorporates all educational activities which involves groups or individuals on line or offline [12]. The Internet-based technologies have transformed traditional in-class learning to a new way of learning and have undoubtedly changed the way we communicate and interact with one another. This has resulted in dramatic changes to education as well. The Internet is now daily used for e-mailing, searching for information, getting news, checking the weather, instant messaging, and online banking by users. It is also used for asynchronous computer-based instruction and primary mode of instructional delivery. This creates live virtual classroom environment with real time and high interactivity among users. E-learning can be categorized into the following:

a) Knowledge Databases

This is a basic form of e-learning based on explanation and guidance on software question with a systematic instruction to the performance of a task. This mode is moderately interactive, meaning that you can either type in a key word or phrase to search the database, or make a selection from an alphabetical list.

b) Asynchronous Training

This form of learning is considered as the traditional form of e-learning which involves self-pace learning, network base, intranet or internet base, sometimes with an instructor through bulletin boards, online discussion groups and emails. It is normally self based with links to leaning and reference materials in place of a life instructor.

c) Synchronous Training

Synchronous training is typically based on real-time with a live instructor facilitating the training. All the users log in at a given time and also have opportunity to communicate directly with the instructor and other users. The schedules can last from a single session to several weeks, months or even years.

Moreover, E-learning like any organized educational activity has complex undertaking which includes technology. Normally institutions seeking to engage in E-learning activities quite often overlook the fact that its successful deployment requires the same level of diligence and rigor in its planning, management and implementation that is necessary in setting up conventional education systems. It also has added elements which include technology infrastructure, which require attention beyond what is necessary in conventional educational settings. Educational institutions with the history of employing alternative approaches to learning and teaching such as distance

education will have many of the prerequisites and dispositions for e-learning already in place which they can easily capitalize and build upon. Meanwhile, conventional campus-based educational organizations which have traditionally relied on residential face-to-face classroom-based learning and teaching activities need to reconsider their values, mission and goals of educational provision in order to adequately accommodate the adoption of e-learning activities.

In recent, time there have been fast evolution in distance learning, from the books sent by mail (first generation of distance learning) to the integrated use of TV transmission, video and audio recordings (second generation) to current interactive real time broadband data transmission (third generation) [4]. Information and Communication Technology infrastructures made up of some multimedia application and cable technologies are not able to reach many potential broadband users due to Cost and the practical limitations[5]. Converting these networks to support deploying wired infrastructure to new areas with low subscriber density is generally commercially unfeasible and requires years of disruptive installation. Thus the need for wide area coverage and availability in non-metropolitan areas make satellite IP/ DVB- based applications very promising for e-learning mainly of remote educational and training purposes.

3. Evolution of DVB-RCS Standards

The development of DVB systems were based on MPEG-2 for digital television and data broadcasting to support encoded and compressed video and audio, and data channels for various information service[6]. It quickly took the center stage and became solutions to all satellite projects for broadcast, broadband and multimedia interactive application for high speed internet and IPTV soon after it was introduced in 1993 [9]. This breakthrough quickly evolved and lead to the second generation of DVB standard as a new and cost effective, efficient, reliable, secure and functional solution. The DVB-S2 could be upgraded by the most effective latest and costless third generation of DVB-S2 ACM (Adaptive Coded Modulation)[16]. The DVB-S is also being used for Television news contribution via satellite (DSNG) applications and for distributing television and radio channels to terrestrial transmitters. DVB-S2 is also designed for interactive transmission via satellite of VoIP and VDVoIP for implementation in E-Learning and other applications anywhere. However the DVB-RCS can be optimized in its usage of VSAT in E-education and others factor relating to space environment and constellation, transmission techniques, satellite antennas systems, VSAT antennas, propagation and interference on space environment. The major consideration for the design and implementation of DVB-RCS solution is the cost-effective provision of a multi-purpose broadband and multimedia space and ground segment capable of supporting a large number of fixed and mobile users for fixed and mobile applications.

4. Architecture of DVB-RCS for E-Learning

There are different network topologies for DVB-RCS configurations namely star and mesh topologies. The star topology is, configured using a central uplink site, this topology has a network operating center (NOC) to transport data back and forth to each remote VSAT terminal. However mesh topology allow each terminal to relay data to another terminal by acting as a hub, minimizing the need for a centralized uplink site. Both architectures can be used in providing services, by service providers to the user. Figure (1a) and (1b) are examples of topologies used for developing system e-learning

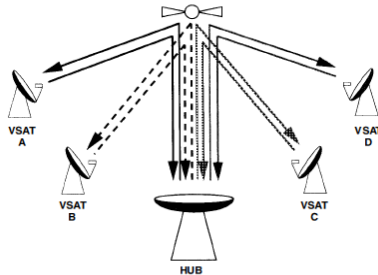


Figure 1 (a): Star topology

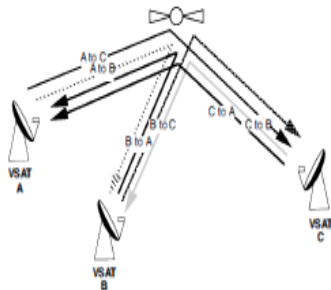


Figure 1(b): Mesh topology

4.1 Space Segment

The space segment is made up of three multipurpose Geostationary Earth Orbit(GEO) satellites, used to obtain global coverage and integrated for communication and navigation. These satellites are used by operators to provide regional, global and spot beam coverage via the satellites to fixed and mobile users. Some of the operators like EUTELSAT, INTELSAT, PanAmSat and others are currently providing L, C, Ka and Ku-band constellation suitable for DVB-RCS systems [9].

4.2 Ground Segment

The ground segment basically consists of a Hub which controls the network, satellite and traffic to remote and mobile users [5]. The Hub controls the networks, satellite and traffic to remote and mobile users and antenna systems interfaces for Ka, Ku, C and L-bands respectively. It provide support service like terrestrial broadband, video broadcasting, universal mobile telecommunications system/General packet radio service (UMTS/GPRS), Asynchronous Transfer Mode (ATM), Terrestrial Telecommunication Network (TTN), internet Services ,cellular, private and public network, virtual private network, fiber optic network and other commercial networks. These services are available to Enterprise and Private Network(EPN),Service Provider Platform (SPP), Broadcasting and content distribution(BCD),Satellite news

gathering (SNG), Satellite emergency and security management (SESM), and Defense information management (DIM).

Moreover, Central to the ground segment is the Hub which includes the following:

- Network control centre—which is responsible for traffic management, system supervision and protocol handling. It provides complex bandwidth management for the return link through four different bandwidth allocation algorithms based on the DVB-RCS standard.
- Forward link subsystem—typically provide the encapsulation of the IP packets into MPEG frames, an MPEG multiplexer and a modulator according to the DVB-S2 standard.
- Return link subsystem—Is a powerful bank of radio receivers that collect the turbo-coded Multiple Frequency Time Division Multiple Access bursts transmitted by all the terminals in the network.
- Reference and synchronization subsystem—Is responsible for synchronization and timing information for the entire satellite network.

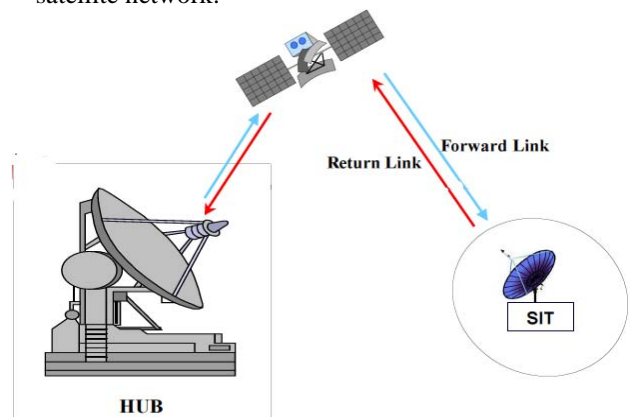


Figure 2: DVB-RCS Hubs System

The SITs and MITs terminals are made up of ideal IDU/ODU satellite devices designed to connect remote end-user PC LAN and IPTV to a DVB-RCS Satellite Network, and can be installed in an office or with some modification on onboard mobiles systems. It provides two-way Multimedia IP communications via adequate satellite at C, Ku or K-band frequencies.

These terminals can be supplied for either desktop or rack mounting onboard ships or aircraft and comes in scalable choice of performance with a variety range of data IPs. This serve governments, corporations, institutions, private companies or home offices offering an open-interface for high-capacity satellite broadband access.

4.3 User Segment

The user segment is the center where data is managed with SITs that are connected to users terminals via LAN or WAN infrastructures. It consist of an outdoor unit (ODU) and an indoor unit (IDU).The Indoor unit (IDU) is responsible for signal processing (modulation, demodulation, multiplexing, demultiplexing, synchronization, and routing) and supports the user interfaces and the IDU box is similar in size to a

domestic CD player houses the network interface (Ethernet), processing unit, receiver (demodulator), transmitter (modulator), the ODU interface, clock generation unit and power supply.

The command and control center is connected via terrestrial network to the DVB-RCS HUB for onward connectivity via satellite to all users anywhere any time.

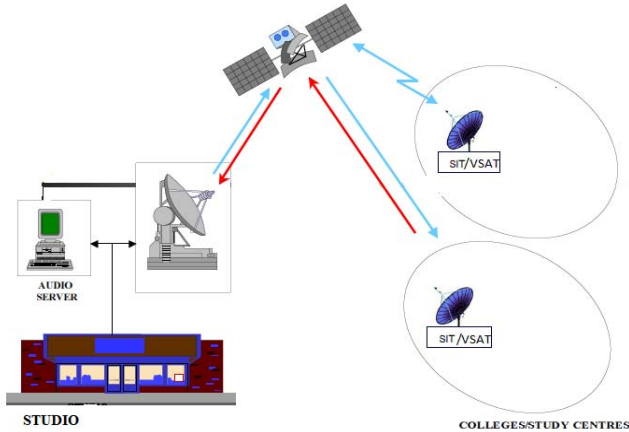


Figure 3: A Network of DVB-RCS Architecture

5. E-Learning Based on DVB-RCS Service

E-learning has now made it possible and cheaper for large populations to be educated, informed, work and collaborate effectively due to advancement and accessibility of satellite communications technologies. DVB-RCS has been in used by some developed countries UK, Spain, Holland to enhance education and training regardless of their locations. Although, Ghana has terrestrial telecommunications networks, its limitations in terms of high speed internet and service extension to suburban, rural and remote locations, makes satellite communications the best choice for distance and collaborative leaning anywhere at any time. However, high speed internet connection will allowed people in urban areas to benefit from using their personal computers to enjoy the traditional form of distance learning via satellite.

Adopting DVB-RCS via satellite network for educational purposes will be a mile stone for a developing country like Ghana and the sub-Saharan region, because It supports all multimedia services, VoIP, VDVoIP for effective learning. Service providers like EUTELSAT, INTELSAT and PanAmSat are already providing satellite service across the region, and will be the best to provide the space segment service and demonstrate the efficacy of the satellite system for interactive distance education, but content generation is the responsibility of the user agencies. They also provides technical and managerial support while end users are expected to provide funds mainly from government. Selected educational institutions will now have to acquire Satellite Interactive Terminals (SITs) or VSAT which will enable them to receive educational programs from the satellite network, the first exclusively in the educational sector, with interaction and questions through audio-video conferencing or text mode or through telephone.

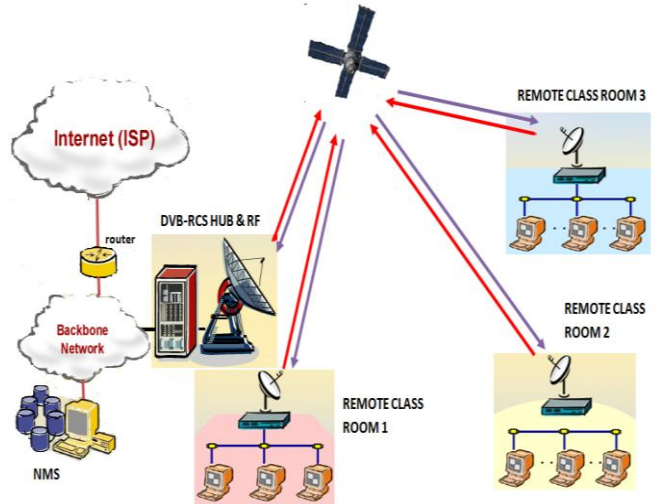


Figure 4: DVB-RCS E-learning configuration

In order to establish E-education over DVB-RCS in Ghana, a location must be chosen in an urban center or commercial center where the E-education teaching center (ETC) or the teaching end (TE) can be establish using the star topology, which has a central uplink site, and a network operating center (NOC) to transport data back and forth to each remote SIT or VSAT terminal as shown in figure 5. The center will then be connected via a terrestrial network to the DVB-RCS Hub for onward connectivity via satellite to schools and training centers in sub-urban, rural and remote locations within the country. The ETC can be connected to urban schools via high speed internet accesses over the terrestrial facilities. The ETC can also be used to manage, inspect and remote control activities in all schools throughout the country.

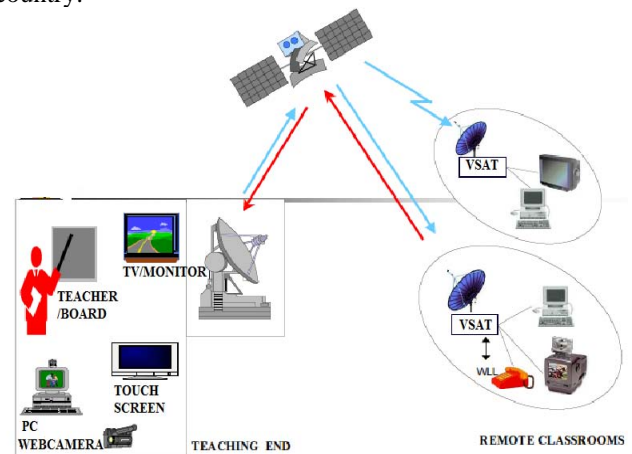


Figure 5: Education Training Center model

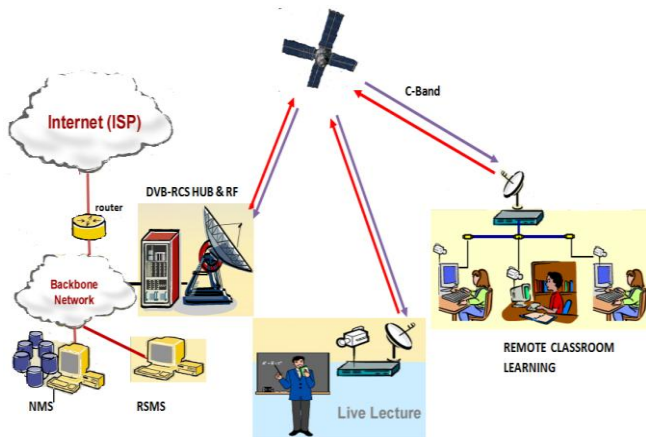


Figure 6: ETC real time e-learning Scenario

All E-learning network in rural, remote and onboard movable or mobile cabins need to install an SIT or VSAT via DVB-RCS remote equipments and connecting it in LAN with few tenth of PC and IPTV terminals as shown in figure 6. The VSAT terminal can also be connected to other LAN users via WiMAX and Wi-Fi facilities. The VSAT antenna is usually fitting on the roof or high mast of the school building. Alternative solutions for E-learning and distance learning may also be establishment of E-learning buses by implementing the same DVB-RCS equipment as shown in figure 7.

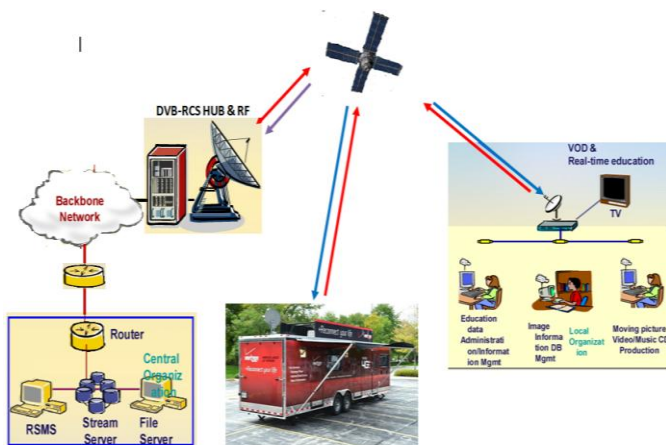


Figure 7: Management and Control of E-education Scenario

6. Conclusion

In developing countries like Ghana e-learning platform for sub-urban, rural and remote areas based on IP-broadband is very minimal and limited. Thus this paper proposes a DVB-RCS via satellite network to accelerate and improve education at lower cost for national development. The DVB-RCS networks technology delivers a two-way VDVoIP and IPTV multimedia connectivity, both between user terminals within the satellite system and between user terminals and the terrestrial network.

This primarily, is to provide connectivity to schools, colleges and higher institutions and to support non-formal education including developmental communication. Implementation of DVB-RCS will allow governments and partners to quickly and cost effectively deploy broadband to rural and remote location with no disruption to existing ICT infrastructure for

e-learning. The state would then be able to address issues related to limited trained and skilled teachers and aspirations of growing student populations at all levels can be met through the concept tele-education. DVB-RCS effectively implemented will lift educational standard in some urban, sub-urban, rural and remote areas countrywide. As it revolutionizes e-learning bridging the academic gap nationwide, the system can also be used to improve communication, effect quality and effective service in the management, control of mobile and maritime communication systems anywhere. Again DVB-RCS solutions can be used by state and private corporations to improve communication and Internet facilities in remote areas for emergency, disaster, security, health care and other E-solutions.

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